

BULLETIN NO. 128.

March, 1910.

COTTONSEED MEAL AS HUMAN FOOD.

BY

G. S. FRAPS, Chemist.



POSTOFFICE:

COLLEGE STATION, BRAZOS COUNTY, TEXAS.



AUSTIN, TEXAS:
VON BOECKMANN-JONES CO. PRINTERS
1910

TEXAS AGRICULTURAL EXPERIMENT STATIONS.

OFFICERS.

GOVERNING BOARD.

(Board of Directors A. & M. College.)

K. K. LEGETT, President.....	Abilene.
T. D. ROWELL, Vice-President.....	Jefferson.
A. HAIDUSEK.....	La Grange.
J. M. GREEN.....	Yoakum.
WALTON PETEET	Dallas.
E. R. KONE.....	Austin.
A. R. MCCOLLUM.....	Waco.
W. P. SEBASTIAN.....	Breckenridge.

PRESIDENT OF COLLEGE.

R. T. MILNER.....	College Station.
-------------------	------------------

STATION OFFICERS.

H. H. HARRINGTON.....	Director.
W. C. WELBORN.....	Vice Director and Agriculturist.
J. W. CARSON.....	Assistant to Director and State Feed Inspector.
M. FRANCIS.....	Veterinarian.
G. S. FRAPS.....	Chemist.
J. C. BURNS.....	Animal Husbandry.
H. NESS.....	Horticulturist.
RAYMOND H. POND.....	Plant Pathologist
WILMON NEWELL.....	Entomologist.
H. L. MCKNIGHT.....	Assistant Agriculturist.
N. C. HAMNER.....	Assistant Chemist.
E. C. CARLYLE.....	Assistant Chemist.
J. B. RATHER.....	Assistant Chemist.
C. W. CRISLER.....	Chief Clerk.
F. R. NAVAILLE.....	Stenographer.
A. S. WARE.....	Stenographer.

STATE AGRICULTURAL EXPERIMENT STATIONS.

GOVERNING BOARD.

HIS EXCELLENCY, GOVERNOR T. M. CAMPBELL.....Austin.
LIEUTENANT GOVERNOR, A. B. DAVIDSON.....Cuero.
COMMISSIONER OF AGRICULTURE, HON. ED. R. KONE.....Austin.

DIRECTOR OF STATIONS.

H. H. HARRINGTON.....College Station.

SUPERINTENDENTS OF STATIONS.

A. T. POTTS, Beeville Station.....Beeville, Bee County.
J. L. WELCH, Troupe Station.....Troupe, Smith County.
W. S. HOTCHKISS, Lubbock Station.....Lubbock, Lubbock County.
J. T. CRUSE, Fort Worth Station.....Fort Worth, Tarrant County.
J. H. TOM, Pecos Station.....Pecos, Reeves County.
H. C. HOLMES, Denton Station.....Denton, Denton County.
_____, Temple Station.....Temple, Bell County.
I. S. YORK, Spur Station.....Spur, Dickens County.
_____, Angleton Station.....Angleton, Brazoria County.
J. K. FITZGERALD, Beaumont Station....Beaumont, Jefferson County.

NOTE.—*The main Station is located on the grounds of the Agricultural and Mechanical College, in Brazos county. The postoffice address is College Station, Texas. Reports and bulletins are sent free upon application to the Director.*

[Blank Page in Original Bulletin]

COTTONSEED MEAL AS HUMAN FOOD

BY G. S. FRAPS.

The use of cottonseed meal as a human food was proposed several years back. For example, breads, etc., prepared from cottonseed meal were served to certain members of the Farmers' Congress held at College Station, Texas, some years ago.

The agitation for the use of this substance as a human food has recently been extended and has attracted considerable attention. Cottonseed breads and other edibles made from cottonseed meal have been placed upon the market at Brenham, Longview, and especially at Ennis, Texas. Mrs. Dan McCarty, of Ennis, Texas, claims to be the first and only purveyor of *cottonseed flour*, bread and cakes, and her products have attracted considerable attention. Mr. J. W. Allison, who has been agitating this matter for some time, induced Mrs. McCarty to place this cottonseed flour bakery upon the market, and the experiment appears at present, to be successful. The following products are being sold: Cottonseed bread, cottonseed rolls, cottonseed steamed bread, cottonseed ginger bread, cottonseed ginger snaps, cottonseed doughnuts, cottonseed Jeff Davis plum pudding. Samples of certain of these goods, and also of the cottonseed flour have been kindly furnished to us by Mr. Allison. They have been subjected to analysis, and the analyses will be discussed below.

COMPOSITION OF COTTONSEED FLOUR.

Cottonseed flour as made by Mr. Allison is cottonseed meal which has been specially treated, so as to remove the hulls as thoroughly as possible. It is also finely ground. Cottonseed flour should be free from hulls, of a bright yellow color, and with a pleasant odor and a sweetish taste.

The analysis of the cottonseed flour furnished us by Mr. Allison, is presented in Table No. 1, together with analyses of average Texas cottonseed meal, wheat flour, fresh beef, and some other foods.

Cottonseed flour contains less crude fiber than cottonseed meal—the significance of this fact being that it contains less hulls. Cottonseed flour resembles meat more closely in its chemical composition than it does wheat flour. It is indeed, quite different in character from wheat flour. Cottonseed flour or meal contains more than twice as much protein as the meats. A careful examination of the table will show that this is due to the *water* contained in the meats. If the meats were as dry as cottonseed meal, they would contain as much protein as cottonseed meal, and much more fat.

Whatever the cause of the difference, however, cottonseed meal contains over twice as much flesh-forming material (protein) as any of the meats. The analyses in the table refer to the edible part of the meat. Part of the meat as purchased is not edible—the unedible part consists chiefly of bone. The average loss in beef flank is 5.5 per cent,

beef loin 13.3 per cent, mutton, leg, 17.7 per cent, and eggs 11 per cent. That is to say, a pound of these foods when purchased contains, on an average, the percentage of unedible material stated above. The presence of unedible material in the meat increases the cost of the edible part.

A pound of cottonseed meal contains over four times as much protein as a pound of eggs, and about the same quantity of fat. It contains over four times as much protein as wheat flour.

Wheat flour, however, contains considerably more nitrogen-free extract, consisting chiefly of sugars and starches. Thus wheat flour is a different kind of food from cottonseed meal.

TABLE I.
Percentage Composition of Cottonseed Flour, etc.

	Protein	Fat	Nitrogen Free Extract	Crude Fiber	Water	Ash
Cotton seed flour.....	48 25	12 16	22 85	3 95	7 21	5 58
Cotton seed meal (Texas).....	47 60	9 50	24 10	6 50	7 00	5 30
Cotton seed meal (average).....	43 40	13 50	22 30	5 40	8 50	7 00
Beef flank.....	19 60	21 10	.....	.....	59 30	0 90
Beef loin.....	16 40	16 90	.....	.....	61 30	0 90
Mutton, leg.....	18 70	17 50	.....	.....	63 20	1 00
Eggs.....	13 20	12 00	.....	.....	73 30	0 60
Wheat flour.....	11 40	1 00	75 10	0 30	12 00	0 60
Rice.....	8 00	0 30	79 00	0 20	12 30	0 40
Cheese.....	25 90	33 70	2 40	.....	34 20	3 80

DISCUSSION OF ANALYSIS.

Protein is the nitrogenous portion of the food, and is used by the body for the production of flesh, or to replace waste of flesh or tissue. No other nutrient can take the place of protein for this purpose. Protein may also be burned in the body for the production of energy, and if an excess of protein is consumed, it will be disposed of in this way. The white of an egg and lean meat are examples of almost pure protein. Protein is exceedingly important because it is the substance of the animal muscles.

Meat is rich in protein, and its peculiar value is due to this fact. Cottonseed meal, however, contains more than twice as much protein as average meat. The chief function of meats is to supply the body with protein. Fat is used by the body to furnish energy with which to do work, or for the uses of the body. The body may be roughly compared to a steam engine. The protein makes up the tissue of the body which corresponds to the boiler and other working parts of the engine. The fats and carbohydrates are the fuel and are burned to "get up steam" to run the body. The body, unlike the steam engine, repairs its own wear, and then burns up the worn material, producing more heat or energy. Fat may also be stored up as such. Fat is a concentrated form of nourishment. A pound of fat has the value of 2.2 pounds of sugars, starch or other carbohydrates. Fat cannot be used to make lean flesh, or to repair loss of lean flesh. Cottonseed meal contains about half as much fat as average fresh meats.

Water is present in all foods, and while its presence is a necessity

for the consumption and digestion of the food, yet it can only be regarded as a diluent of a food when the food is being purchased. The food is not purchased for the water which it contains, but for other substances than water.

Nitrogen-free extract of human foods, is composed mostly of sugars and starches, and other bodies known to chemists as *carbohydrates*. These nutrients furnish the body with energy, or may be converted into fats and stored up, but they cannot produce flesh or repair tissue.

The nitrogen-free extract of cottonseed meal is composed most largely of a sugar known as *raffinose*. It also contains some pentosans. Cottonseed meal contains *no starch*. It could thus be used for a diet in cases of sickness where starch is not desired.

Crude Fiber is the woody fiber, not very well digested by human beings, and not present in any quantity in ordinary human foods, though it may be present in larger quantities in greens, such as turnips, and any coarse vegetable food. The chief objection to the use of alfalfa as a human food is the quantity of crude fiber which it contains. If cut young, the alfalfa is not so fibrous.

Ash is the residue left on burning the material. It contains substances which are essential to the welfare of the body, especially for the bones, but the discussion of these is aside from our topic.

Bases in Cottonseed Meal.—Two bases, known as betain and cholin, occur in cottonseed meal, to the extent of about 0.26 per cent. About 80 per cent appears to be betain. Cholin is stated by some to have toxic properties, by others, not. Betain is recognized as non-poisonous. An alkaloid termed gossyain is also claimed to have been extracted from cottonseed meal.

DIGESTIBILITY OF COTTONSEED PRODUCTS.

The quantity of the nutrients digested is equally as important as the quantity present in the food. We have no digestion experiments with cottonseed meal on human beings. Man digests animal foods almost completely. Vegetable foods are digested less thoroughly. While, for example, the protein of meats and fish are digested to the extent of 97 per cent, the protein of cereals is digested about 85 per cent; of legumes about 78 per cent, and of vegetables in general about 83 per cent.

The digestibility of cottonseed meal with steers or sheep is shown below.

TABLE II.
Average Digestibility of Nutrients of Cottonseed Meal, etc.

	Protein	Fat	Nitrogen Free Extract
Cotton seed meal (by animals).....	88 4	93 3	60 6
Corn meal (by animals).....	67 9	92 1	94 6
Hulled corn (by man).....	90 9	(90)	97 0
White bread (by man).....	93 9	(90)	99 1
Wheat shorts (by animals).....	79 8	86 3	81 3
Meat (by man).....	97	98	98

Referring to the above table, we find that of 100 parts protein fed to an animal in cottonseed meal, 88.4 parts are digested. Of 100 parts fat, 93.3 parts are digested. The protein of cottonseed meal is more easily digested than the protein of corn meal, or wheat shorts.

We find by the above table, that while animals digested only 67.9 per cent of the protein of corn meal, man digested 90.9 per cent of the protein of hulled corn (lye hominy). The nitrogen-free extract is also digested to a greater extent by man. We also find that the protein and nitrogen-free extract of white bread are digested by man more than protein and nitrogen-free extract of wheat shorts is digested by animals. The cooked condition of the food eaten by man may, of course, have something to do with the difference.

While the comparison of man and the animals is not made on the same foods, yet we feel justified in believing that the digestive capability of man for *concentrated food* is equal to that of animals. Hence it is probable that the protein and fat of cottonseed meal has a high digestibility for man. The protein of cottonseed meal is probably digested to an equal extent to that of cereals (digestibility 85 per cent) and greater than that of legumes (78 per cent). We could not expect the nitrogen-free extract of cottonseed meal to be digested so well. Digestion experiments on man must be made before we can ascertain definitely the digestibility of cottonseed meal. Even if the digestibility of the protein of cottonseed flour by man should be less than 50 per cent, a pound of cottonseed flour would contain more digestible protein than a pound of meat. But it is probably nearer to 85 per cent. *Cottonseed flour would be a meat substitute. It is not a flour substitute*, being low in the sugar and starches in which flours are so rich. Protein is the chief constituent of meats, and is generally considered as the most expensive nutrient of our foods.

DIGESTIBLE NUTRIENTS IN FOODS.

In the table below, we have calculated the digestible nutrients in foods, based on the values given above. We have allowed the values of 80 per cent for the digestibility of protein of cottonseed meal, and 60 per cent for the nitrogen-free extract.

In order to be able to make an exact comparison between vegetable foods and animal foods, we have in all cases calculated the digestible fat to carbohydrates, by multiplying the fat by 2.2. In the table, we thus have a comparison between two values, protein or the lean-flesh value, and the carbohydrate value.

It is seen from the above table, that cottonseed meal contains twice as much digestible protein as average beef flank, but not as much carbohydrates. In comparison with all other foods, cottonseed meal contains larger quantities of digestible protein, and a much less proportion of digestible carbohydrates.

Pounds Digested by Man from One Hundred Pounds Eaten.

	Protein Digested.	Carbohydrates Digested (Including fat multiplied by 2.2)	Relative food value. Giving protein twice the value of carbohydrates.
Cotton seed meal.....	38 0	32 6	108 6
Beef flank.....	19 0	44 0	82 0
Beef loin.....	15 9	36 4	66 8
Mutton, leg.....	17 1	36 5	70 2
Eggs.....	12 5	25 1	47 7
Cheese (full cream).....	25 1	72 8	122 2
Wheat flour.....	9 7	75 6	85 0
Rice.....	6 8	78 0	91 6

The value of a food depends not only upon the digestible nutrients which it carries, but also upon the work required in digestion, upon the bodies produced by digestion, and upon other conditions concerning which we have at present little information. This aspect of the matter has not received a great deal of study, and definite information cannot be given. It appears probable that there is little difference in the values of the digestible portion of fat and starches from different foods. Other constituents of the nitrogen-free extract may have different values. It appears probable that all the products of the digestion of proteids cannot be combined into animal proteids and that the waste portions, which can only be oxidized to furnish energy, vary with different foods. It is probable that a greater loss of this kind occurs with vegetable foods than with animal foods.

DESCRIPTION OF COTTONSEED BAKERY GOODS.

The bakery products which we examined had a yellow or brown color, and a pleasant taste. They are, in all respects, entirely palatable. What was left after the samples were taken for analysis, was eaten by the various members of the laboratory staff and by visitors.

The yellow or brown color is, of course, not noticeable in ginger snaps or gingerbread. The color cannot fail to attract attention to the light bread, or steamed bread. This color may be considered objectionable by some. We do not believe, however, that attempts should be made to bleach the cottonseed meal. Bread made from cottonseed meal is different in nutritive value from ordinary bread, and it is well that the color should call attention to this fact.

The following is a brief description of the breads subjected to analysis:

Cottonseed Biscuits, made of one part cottonseed flour to three of ordinary flour in the usual way for making biscuits, by Mrs. F. These biscuits have a brown color, and a good taste, though the flour is evident.

Cottonseed Ginger Snaps, made by Mrs. McCarty, of Ennis, Texas.—Like all ginger snaps, these had a brown color. We were unable to distinguish between these ginger snaps made with cottonseed flour, and those made with ordinary flour.

Cottonseed Ginger Cake.—Like the ginger snaps, we could detect no difference between this ginger bread and ordinary ginger bread.

Cottonseed Steamed Bread.—This had a brown color, a somewhat sweet taste, and was quite good.

Cottonseed Bread.—This had a yellow color, a sweetish taste, and was agreeable to the taste. It was not eaten as rapidly as the other products because we did not furnish any butter with it. It did not appear to be as light as ordinary bread.

TABLE III.
Composition of Cottonseed Bakery Products.

	Protein	Fat	Crude Fiber	Water	Ashl	Nitrogen Free Extract
Cotton seed bread.....	14 13	4 85	1 95	24 98	2 11	51 98
Cotton seed steamed bread.....	13 48	7 80	2 13	40 00	3 00	33 59
Cotton seed ginger bread.....	17 19	11 63	2 60	22 80	2 80	42 98
Cotton seed ginger snaps.....	16 32	14 70	2 71	6 50	2 13	57 64
Cotton seed biscuits.....	18 52	11 42	3 05	11 23	4 25	51 53
White bread (average).....	9 2	1 3	1 51	35 3	1 10	53 10
Ginger bread (average).....	5 80	9 0	9	18 8	2 9	63 5
Ginger snaps (average).....	6 5	8 6	7	6 3	2 6	76 0

DISCUSSION OF ANALYSIS.

All the cottonseed bakery products, as can be expected, are much richer in protein than those made with ordinary flour. Cottonseed bread contains about fifty per cent more protein than ordinary bread. The difference would be less if the two contained more nearly the same quantity of water. Four or five parts of flour to one part cottonseed meal was probably used for this bread. Cottonseed ginger bread contains three times as much protein as ordinary ginger bread. Cottonseed ginger snaps contain nearly three times as much protein as ordinary ginger snaps.

These quantities of protein will decrease the need of eating meat.

IS COTTONSEED FLOUR WHOLESOME?

Breads, etc., baked with cottonseed flour, when properly made, are appetizing. Practical experience must determine whether cottonseed flour will be wholesome as a human food. When consumed in such moderate amounts as should be used we cannot anticipate injurious effects. Cottonseed meal when fed continuously to pigs (making up about one-fifth of the ration) may cause death after several weeks. (See Bulletin No. 78 of this Experiment Station.) Pigs may consume cottonseed meal for some time without injurious effects, especially if fed in smaller amounts than as stated above. Pigs have been fed on *cottonseed meal and corn* successfully for 156 days.

Disturbances of health have occurred when cottonseed meal was fed to other animals. From the variety of symptoms of sickness and post-mortem results, it appears that the sickness may be due to several causes rather than one specific thing. The sickness is variously ascribed

to loose lint, the large amount of fat, the hard and sharp seed coats, moldy cakes or meal, the presence of injurious substances in the meal, etc. Moldy cottonseed cake or old meal have often caused injury. A number of sheep and lambs have died from eating cottonseed cake, the cause of the injury being assigned to *over-eating*. Cottonseed roots contain an active medicinal principle, but we have no reason to believe that this substance is found in the seed.

In view of these facts stated above, we would not advise anyone to make cottonseed meal a considerable portion of their daily diet for several weeks. One should also be careful not to over-eat at any one time. Especially should one avoid old or damaged meal. It is possible that if a person was to make as much as one-fifth of his daily diet consist of cottonseed meal, after thirty days or longer, he might become sick. It is neither likely, necessary, or desirable, however, that cottonseed meal should enter into the diet in such quantities.

The dietary standards of Dr. Atwater require 125 grams protein per day for a man doing moderately heavy work. These standards are based upon observations of what people eat, and not upon rigid tests of various rations upon men, which would (it appears) give much lower results. In any event, an American man at moderately heavy work, eats this quantity of protein. About 50 to 60 per cent of this protein is eaten in the form of animal food; that is, in meats, poultry, fish, eggs, milk, cheese, and other products of animal origin. The amount of meat eaten by men varies greatly, but it may be estimated at about 7 ounces per day. To replace this amount of meat would require about 100 grams or $3\frac{1}{2}$ ounces cottonseed meal, which should make up about ten to twenty per cent of the daily ration. This would be the quantity of cottonseed meal which would be eaten, on an average, if it were used to replace meat entirely in the daily ration.

Some other vegetable food would have to be used with it, because cottonseed meal does not carry as much energy-producing material as meat.

It is hardly probable that it would be found desirable to use as much cottonseed meal as indicated above. Two ounces a day would be a fair amount to eat.

Cottonseed meal or flour is very rich in protein. Too much protein in the diet is harmful—so is too much starch, etc. Only moderate amounts of cottonseed flour, therefore, should be introduced into the diet. Excessive amounts might cause disturbances due to the one-sided character of the diet. Too much emphasis cannot be laid upon this fact, for the reason that cottonseed meal being a flour, and its properties not familiar to us, and also cheap and palatable, too much of it may easily be eaten. Occasionally moderate excess of this kind might do no harm, but a continuous excess of protein is likely to cause trouble.

As regards the agreement of cottonseed meal with individuals, we cannot but think it wise to quote here from Dr. Atwater, remarks concerning food in general:

"Different persons are differently constituted with respect to the chemical changes which their food undergoes in digestion and the effect produced, so that it may be literally true that one man's meat is an-

other man's poison. Milk is for most people a very wholesome, digestible, and nutritious food, but there are persons who are made ill by drinking it, and they should avoid milk. The writer knows a boy who is made seriously ill by eating eggs. A small piece of sweet cake in which eggs have been used will cause him serious trouble.

"The sickness is nature's evidence that eggs are for him an unfit article of food. Some persons have to avoid strawberries. Indeed, cases in which the most wholesome kinds of food are hurtful to individual persons are, unfortunately, numerous. Every man must learn from his own experience what food agrees with him and what does not."

HOW MUCH COTTONSEED MEAL TO USE.

According to Atwater's standards, a man at moderately active muscular work should eat 125 grams protein, and sufficient fat and carbohydrates to make a total fuel value of 3400 calories.

These needs could be met by a ration of 140 grams cottonseed meal and 840 grams corn meal, or five ounces cottonseed meal and 30 ounces of corn meal. This ration would give over 56 grams protein in cottonseed meal, and 7 grams protein in corn meal.

In a number of studies of the diet of American people, it was found that approximately 60 per cent of the protein comes from animal sources, and 40 per cent from vegetable sources. These studies were made some time ago, and the proportion of animal food may be less now that meat has increased so much in price. Animal food includes, however, milk, butter, cheese, eggs, and other animal products in addition to meat.

As pointed out in preceding pages, cottonseed meal is a meat substitute, and not a substitute for flour, rice, corn and other vegetable foods. We could hardly expect people to abandon animal products entirely and substitute cottonseed meal and other vegetable products. If we replace 6 ounces of meat by three ounces of cottonseed meal, that would be the maximum we could expect.

We are, therefore, inclined to believe that the maximum amount of cottonseed meal which should enter into the diet is two to three ounces per day. The conditions under which such a diet may prove injurious must be established. It is possible that larger quantities of cottonseed meal might be eaten for a long time without any deleterious effect whatever. It is also possible that this quantity, continued for a long time, might eventually cause injury.

There is danger that cottonseed meal will be eaten *in addition* to the regular diet, rather than as a *substitute for* protein of the meat diet. Such a use cannot be recommended, unless the diet is known to be deficient in protein. A diet too rich in protein, *may easily* cause trouble. It is best, therefore, to consume only moderately daily amounts of cottonseed meal.

HOW TO USE COTTONSEED MEAL.

To those wishing to test or use cottonseed flour or meal, we offer the following suggestions:

The flour should be bright in color, of a sweet odor and free from any trace of rancidity.

Cottonseed meal may also be used. It should be of a bright yellow color, and have a pleasant odor. Meal which is dark in color should not be used. The meal selected should be finely ground. Hulls and lint should be removed as thoroughly as possible by sifting the meal through an ordinary flour sifter. *By all means avoid old meal or damaged meal.*

On account of the fact that cottonseed meal should be used as a meat substitute, and for the further reason that cottonseed meal is very rich, and an excess of it might easily be eaten, this meal should never be used *alone* in preparing cakes, etc. It should always be used with wheat flour or corn meal, or in mixture with other flour or meal in the proportion of *not less than* one part of cottonseed flour or meal to four parts of other flour or meal. Five or six parts of flour or meal would be better. Diluted in this way, there is little danger of one eating an excess of protein, unless he continues to eat his usual quantity of meat or other animal foods, for which he is substituting the cottonseed meal.

The mixture of cottonseed meal and flour or meal could be used for the preparation of bread, cakes, biscuits, and for other uses to which ordinary flour is put. Some experience is necessary in cooking with cottonseed meal, just as it is necessary in all other cooking, and if one should not secure good results the first trial, one must remember that others have secured *palatable foods* with cottonseed meal, and the failure is due to lack of experience or knowledge. We do not mean to say that any great amount of special experience is required to use cottonseed meal; any good cook ought to be able to get good results with it at almost the first trial.

WHO CAN USE COTTONSEED MEAL.

Cottonseed meal could be used to replace meat in any diet, in the proportion of one ounce of cottonseed meal to two ounces of meat. The daily ration should not exceed 2 or 3 ounces.

Cottonseed meal could be used to increase the protein ration of those who are at present consuming quantities below the standard. The Southern negro who lives upon fat meat and corn bread, eats considerably less protein than is called for by Atwater's standards. The addition of cottonseed meal to his diet, at the rate of about two ounces a day, would improve his ration in this respect.

Negro families in Alabama eat only 62 grams protein per man per day, on an average, living largely upon fat meat and corn meal. Some consume as low as 16 to 24 grams protein per man per day. Atwater's standards call for 125 grams per day for moderate work. According to Chittenden, a low protein diet makes for muscular endurance. Cot-

tonseed meal introduced into such diets as referred to above, would increase the protein at a very moderate cost. It is to be hoped that attempts will be made to introduce it in such diets to some extent, in order that we may secure practical experience of its qualities and food values. A mixture of five parts corn meal to one part cottonseed meal could be used.

Other classes of people living on a low protein diet, according to Atwater's standards, are, poor families in New York, consuming 93 grams protein per man per day on an average; laborers in Pittsburg, consuming 80 grams; Mexican families in New Mexico, 94 grams; Italian mechanics in Naples, average 76 grams.

There are other classes of laborers, particularly in foreign countries, whose daily ration is deficient in protein, according to our dietary standards. The addition of cottonseed meal to their daily ration, would improve it in this respect.

FINAL WORD.

Cottonseed meal is a new proposed human food and very rich in protein. Only experiments and experience can tell us the part that cottonseed meal should take in our diet and whether or not it may prove injurious. In the quantity that it should be used to replace meat, or to reinforce the diet of those whose diet requires reinforcing in protein, it will probably prove wholesome and harmless. It is well worth testing, but we must have full experience before we can have full knowledge.

SUMMARY AND CONCLUSIONS.

(1) Cottonseed flour is richer in protein than meat, and resembles meat more than it does wheat flour, rice, corn meal, or other vegetable food.

(2) Cottonseed flour could be used as a meat substitute.

(3) Cottonseed flour, alone or mixed with wheat flour can be used to prepare bread, ginger cakes, puddings, cakes, etc., which are appetizing.

(4) We have no reason to believe that cottonseed flour will not be a wholesome human food, when used in small amounts to replace meat, or to reinforce a diet poor in flesh foods.

(5) Cottonseed flour, being rich in protein, should not be consumed in such quantity as to make the diet one-sided, and too rich in protein. One must be careful not to over-eat it.

(6) Cottonseed meal may be used as a meat substitute, in the proportion of one ounce of meal to two of meat.

(7) Cottonseed meal can be used to reinforce the diet of those whose diet is deficient in protein.

(8) Cottonseed meal should always be mixed with flour or meal, and with not less than four parts flour or meal to one of cottonseed meal.

(9) Cottonseed meal may not agree with some people. Every man

must learn from his own experience what food agrees with him, and what does not.

(10) Moldy or damaged or inferior cottonseed meal should be avoided, because it may cause sickness.

(11) Only experience and experiments can tell us the part which cottonseed meal should play in nutrition and under what conditions it may prove unwholesome.